ENGINEERS AUSTRALIA

Western Australia Division

ENGINEERS
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NOMINATION OF

PILBARA HEAVY HAUL RAILWAYS

FOR AN ENGINEERING HERITAGE AUSTRALIA ENGINEERING HERITAGE AWARD

First train about to leave Tom Price
June 1966

PREPARED BY ENGINEERING HERITAGE WESTERN AUSTRALIA

ENGINEERS AUSTRALIA, WESTERN AUSTRALIA DIVISION

October 2015

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Pilbara Rail Nomination Rev 6

1 INTRODUCTION

The Pilbara Heavy Haul Railways have become one of the world's largest and most significant railway systems. The railways are an integral part of a major industry involving the mining, processing, railing and shipping of iron ore. Starting from scratch in the 1960s, the Pilbara region of Western Australia has become one of the world's highest-producing iron ore mining provinces. This required the development of new mines, railways, roads, towns, ports, power and communication systems and processing plants in a region that was then largely occupied by Aboriginal groups and the pastoral industry.

Remote from Perth and other centres of population, this development needed the provision or upgrading of all the facilities normally associated with industrial areas and their supporting communities. From the pioneering days of the 1960s there has been continual expansion and new development activity in the region. Many new mines have been established along with the necessary infrastructure. With the region's still very extensive iron ore reserves and a continuing demand for the product, this development is likely to go on at some level for many years to come.

This heritage nomination is intended to recognise the significance of the whole of the Pilbara railway system, but concentrates on the four original heavy haul railways. These are the Mt Goldsworthy-Port Hedland (Goldsworthy Railway), Paraburdoo-Tom Price-Dampier (Hamersley Railway), Newman-Port Hedland (Mt Newman Railway), and Pannawonica-Cape Lambert (Robe River Railway) lines. These railways are still operating, having been upgraded and added to over the last 50 years.

Ownership of the railways, mines and associated infrastructure has gone through various permutations over the years. These have included direct ownership, joint ventures and separate companies formed to operate the developments. The Goldsworthy and Mt Newman railways are now controlled by BHP-Billiton or related companies, while the Hamersley and Robe River railways are controlled by Rio Tinto Iron Ore or related companies.

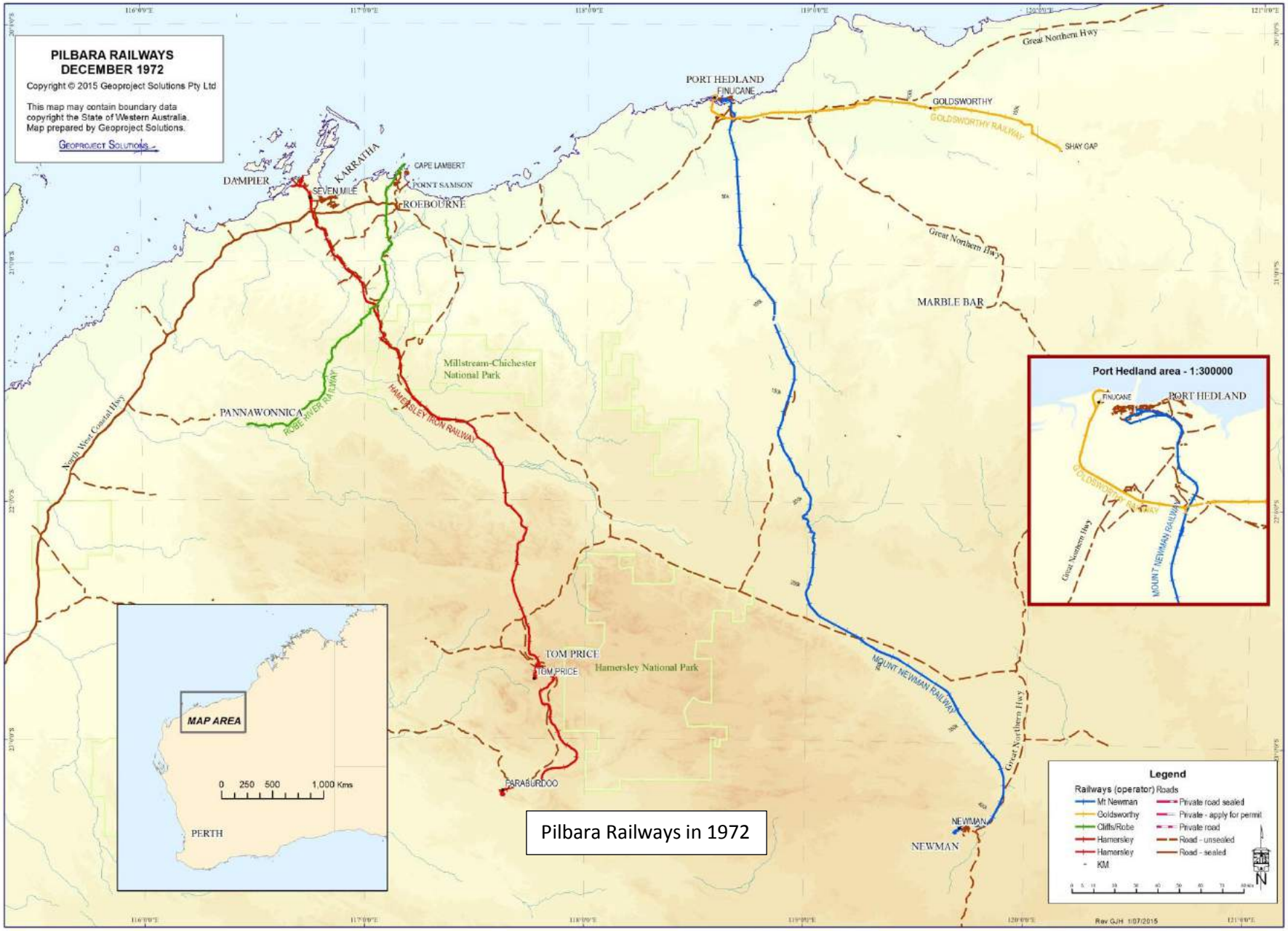
Rio Tinto supports the nomination for heritage recognition of their railways, and these are the subject of this formal nomination. In 2016 the company will be celebrating 50 years since its first shipment of iron ore from the Pilbara. It has asked if the placing and unveiling of the proposed heritage markers can be carried out that year, in conjunction with other commemorative activities relating to the original development of the overall mining project.

Whilst only two of the four earliest railways are being nominated for heritage recognition at this stage, it is considered most appropriate to include descriptions of all four. This is in order to recognise and illustrate the overall pioneering development of the railways serving the Pilbara iron ore mining industry and their significance to Australia. It is also relevant that significant collaboration took place between the companies developing the early railways in establishing engineering standards and practices. It is intended that at a later date the original BHP-Billiton railways will be nominated for formal heritage recognition. Mention is also made of subsequent development of the original heavy haul railways, together with the more recent railways built or under construction by Fortescue Metals Group to the Solomon and Chichester hubs, and by Hancock Prospecting to the Roy Hill mine.

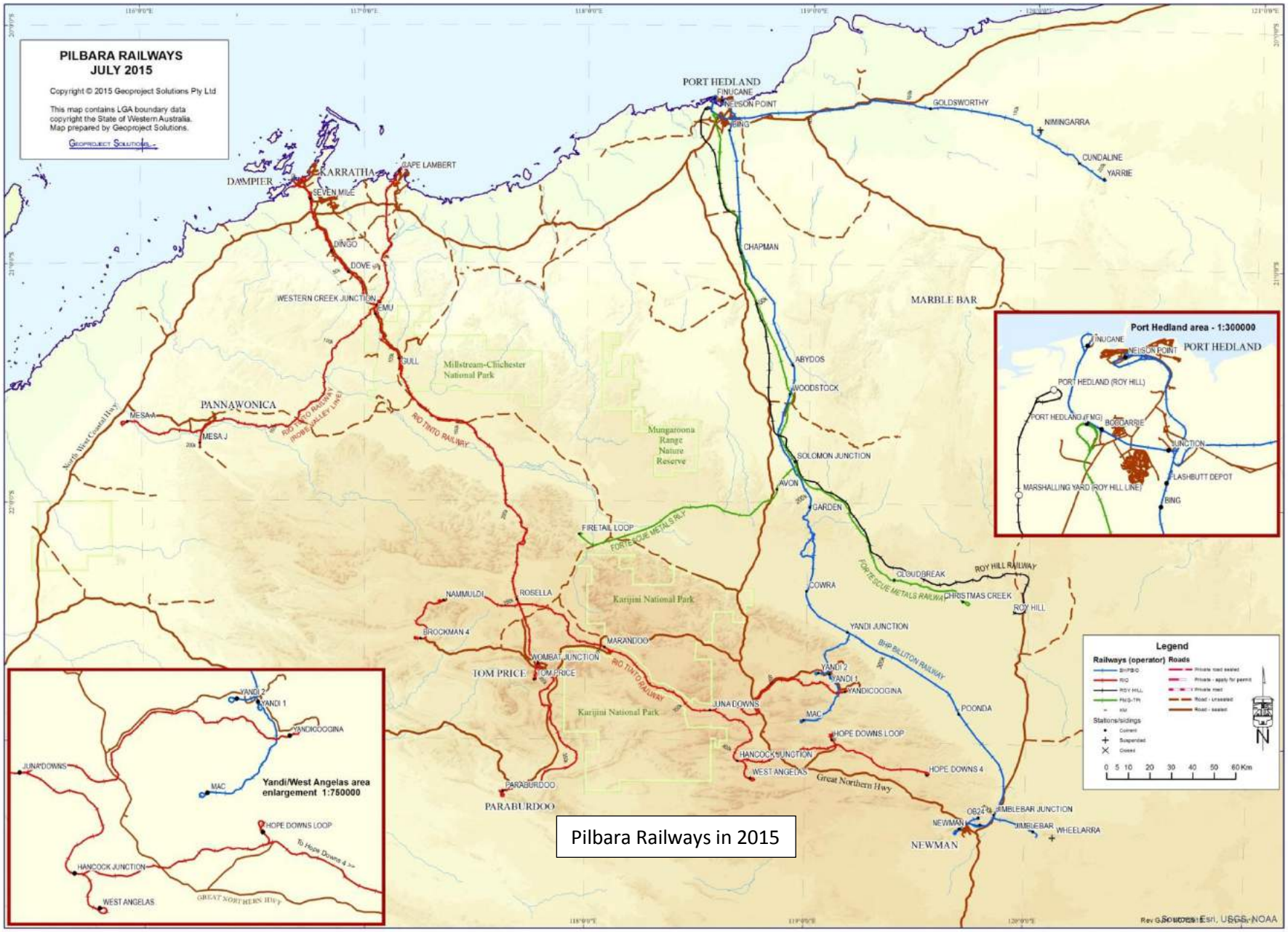
2 DEFINITION AND SCOPE

As described in the Introduction, the title of the works being nominated is the Pilbara Heavy Haul Railways. The scope of the interpretation plan and commemorative activities now proposed covers two of the four original railways, namely the Hamersley Railway and the Robe River Railway. These two are now operated by Rio Tinto. Nomination of the other two, now operated by BHP Billiton, is subject to further consideration.

The locations of the railways are shown in the following maps, provided by courtesy of Geoproject Solutions Pty Ltd.



Pilbara Railways in 1972



Pilbara Railways in 2015

3 STATEMENT OF SIGNIFICANCE

The heavy-haul railway systems in the Pilbara region of Western Australia were initiated in the 1960s. This followed the Commonwealth Government's change in policy to allow the export of iron ore and the subsequent commencement of major mining developments in the region. This has led to the development of the industry that now produces Australia's largest export commodity by value and weight and has contributed greatly to the nation's prosperity. In 2013/14 iron ore exports represented 22.5% by value of all goods and services exports, almost double the value of coal, the next highest.

The original railways connected four mines to ports at Port Hedland, Dampier and Cape Lambert. They were the first standard gauge, heavy haul railways in Australia, and the first extensive privately owned and operated railways. They have since expanded to cover many more mines and now comprise major systems with a total track length of nearly 3,000 km. They are significant engineering achievements. Extensive investigations and research were carried out to build on the limited pre-existing Australian experience with heavy haul railways. The earliest projects required innovation to overcome local issues including high temperatures, cyclonic weather, remote locations, minimal existing infrastructure, lack of prior design and construction experience in the area, and lack of data on local conditions, particularly rainfall and runoff.

The outcomes include the country's first major non-government railways, which carry the world's longest and heaviest regularly-scheduled trains. Trains more than 3.5 km long routinely haul more than 200-300 cars and 20-30,000 tons of iron ore. The early railways were built under demanding physical and technical conditions and provided the basis for further developments over the past 50 years. These railways are an essential component of the iron ore production industry and an important part of the history of the Pilbara.

The Pilbara railways can be considered of international significance, not only for their high capacity and productivity, but also for the technical research and innovation that have been a feature of their operation from the beginning. This has attracted interest from heavy haul railway operators in other countries. In the early stages of operation the planned quantities of ore to be hauled were quickly exceeded, leading to failures and maintenance difficulties. Heavy haul railways in the United States suffered similar problems. Whereas the US companies decided to reduce the loadings, the Pilbara companies decided to increase the railway capacities by upgrading the components with the support of an intensive research programme.

4 HERITAGE RECOGNITION AWARD NOMINATION

The Administrator
Engineering Heritage Australia
Engineers Australia
Engineering House
11 National Circuit
BARTON ACT 2600

Name of Work: **Pilbara Heavy Haul Railways – Hamersley and Robe River components**

The above works are nominated for an

Engineering Heritage Recognition Award

Location:
This nomination refers to the heavy haul railway systems that serve and form part of the iron ore mining industry in the Pilbara region of Western Australia. In particular it covers two of the original components, namely the Hamersley Railway and the Robe River Railway. These railways have been upgraded over the years and continue in use as part of an expanded network. The Hamersley Railway runs between Paraburdoo and the port at Dampier via Tom Price, while the Robe River Railway runs between Pannawonica and the port at Cape Lambert. The coordinates of these points are as follows:

Paraburdoo:	23°12'04" S;	117°40'16" E
Tom Price:	22°41'38" S;	117°47'42" E
Dampier:	20°39'36" S;	116°42'36" E
Pannawonica:	21°38'00" S;	116°20'00" E
Cape Lambert:	20°35'34" S;	117°10'50" E

Owner:
The Hamersley Railway is owned by Hamersley Iron, a fully-owned subsidiary of Rio Tinto. The Robe River Railway is owned by Robe River Iron Associates, of which Rio Tinto is the majority owner. Both railways are operated by Pilbara Iron, a wholly-owned subsidiary of Rio Tinto. Rio Tinto as the owner and majority owner has been advised of this nomination and a letter of support is attached.

Rio Tinto's address is: 152-158 St Georges Terrace, Perth WA 6000

Access to site:
Access is available by a combination of public roads and private rail access roads. Travel on the latter can be undertaken by arrangement with Rio Tinto.

Nominating body:
Engineering Heritage Western Australia, Engineers Australia Western Australia Division

Ian Maitland.

Ian Maitland, Chair EHWA
Date: 30 October 2015

5 OWNER'S LETTER OF AGREEMENT

Rio Tinto

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Andrew Harding
Chief Executive Iron Ore

4 September 2013

Professor Mark Bush
Chair
Engineering Heritage WA
712 Murray Street
West Perth WA 6005

Dear Professor Bush

Thank you for your letter regarding the proposed Engineering Heritage Recognition of Rio Tinto's Pilbara rail network. I was impressed by the quality of promotional material you have developed in support of the heritage awards which provide an interesting historic record of engineering achievement and contribution to West Australian society.

Recognition of our Pilbara Rail Network by Engineers Australia would be an honour which we would be pleased to support. However, I have an alternative scenario which I would appreciate you considering.

In 2016 Rio Tinto will celebrate the 50th anniversary of our iron ore business in Western Australia. The recognition of key infrastructure such as our Mt Tom Price mine, Dampier Port and Pilbara Rail network by Engineers Australia would be a great addition to our celebrations and I believe provides an interesting angle for the promotion of the proposed award.

In the first instance can I ask you to contact Chris Richards, GM Communications & External Relations, PH 9205 0382 or email chris.richards@riotinto.com to discuss further.

Yours sincerely

Andrew Harding
Chief Executive Iron Ore

6 HISTORICAL BACKGROUND OF THE PILBARA

The Pilbara region of Western Australia has an area of about 505,000 km^2 and covers the Shires of Ashburton, East Pilbara and Port Hedland and the City of Karratha. (The Shire of Roebourne became the City of Karratha on 1 July 2014). It extends from the Indian Ocean to the Northern Territory border. To the north is the Kimberley region, while it adjoins the Gascoyne, Mid-West and Goldfields-Esperance regions in the south. At the 2011 census its population was about 60,000. The 3 billion year-old landscape includes a coastal plain, inland ranges and desert. The Pilbara has WA's highest town, Tom Price, and Australia's reputed hottest town, Marble Bar. It also contains three national parks.

Pilbara Region (from Pilbara Regional Council website)

The first inhabitants of the Pilbara were Aboriginals, whose history of occupation goes back some 30-40,000 years. They have left a rich cultural heritage, with the Burrup Peninsula and the surrounding Dampier Archipelago having one of the highest concentrations of rock art in the world. In the inland Pilbara there are many outstanding examples of the art of the engravers. Several rock shelters in the Pilbara area have been studied, particularly in the Abydos-Woodstock Protected Reserve. Occupation here extending back at least 20,000 years has been determined. Aboriginals continue to have a strong presence in the region. According to the Wangka Maya Pilbara Aboriginal Language Centre there are more than 31 Aboriginal cultural groups in the Pilbara, each with its traditional location.

European settlement and subsequent changes in land use have led to movement off traditional land and changes to the way traditional law is practised, with Aboriginals being involved in wider

Australian society while still maintaining an involvement in their custodian role. All the present-day mining companies have active programmes for involving Aboriginals in the development and operation of their projects.

The first European contact with the North West coast may have been by Portuguese traders and explorers in the 16th Century, although there is no confirmed documentary evidence of this. The Dutchman Abel Tasman mapped the coast from the eastern side of Cape York Peninsula to North West Cape in 1644, covering some 5000 kilometres. In January 1688 William Dampier was the first Englishman to set foot on the Australian mainland, visiting the Kimberley coast at King Sound and the mouth of the Fitzroy River in WA. In 1699 he landed at Shark Bay and spent two weeks there. He then charted the coast to the north for 1000 kilometres, ending at the group of islands now known as the Dampier Archipelago near present-day Karratha.

In 1803 the Frenchman Nicolas Baudin surveyed 1500 kilometres of coastline from North West Cape to the Bonaparte Archipelago. A more detailed survey of the coast was carried out between 1818 and 1822 by Phillip Parker King, who reported somewhat more favourably on the prospects for settlement than had earlier explorers.

It was the expedition led by Francis Gregory of the Surveyor General's department in 1862 that paved the way for European settlement and development in the North West. Following its colonisation in 1829, early settlers in the Swan River Colony had concentrated on the southern part of the colony. The motivation for Gregory's expedition was the hope by British manufacturers and entrepreneurs that a large area of land suitable for growing cotton could be found, given that supplies from America had dried up due to the civil war there. The expedition travelled inland, and spent more than five months exploring the country between the Ashburton River in the south and the De Grey and Oakover Rivers in the north. Gregory reported favourably on the land's potential for agricultural development, and such was his reputation that settlers began to move into the area. However it was not cotton growing that developed, but pastoralism and pearling.

Exploration of the country inland continued, both by pastoralists and the government, travelling out from a base established in Roebourne near the harbour at Cossack. Land tenure regulations for the region came into operation in 1863 and in the same year the first settlers arrived. Walter Padbury and John Wellard were among the first to arrive at Cossack, bringing sheep with them. By 1869 there were more than 39,000 sheep in the region. The early settlers and government officials struggled through many difficulties including remoteness and the harsh climate, but gradually the pastoral industry began to develop. Local Aboriginals carried out much of the work on the pastoral stations.

Cossack was the North West's first town and port, which was originally known as Tien Tsin Harbour. It operated as the port for the area's pastoral produce and gold mining industry until difficulties in keeping the harbour clear of silt led to Point Samson taking over as the main port in 1910. Cossack also developed as the pearling industry's main port from the 1860s to the 1880s when Broome became the centre. The population of Cossack gradually decreased and it is now a historical ghost town.

Roebourne became the administrative centre and was proclaimed as a town in 1866. By 1881 it had a population of 113 Europeans out of a total for the district of 1003. In addition to its role in the pastoral industry, the town was a service centre for pearling and mining, the latter following the

discovery of gold in 1887. The population fluctuated for some years and with the movement of many miners to discoveries in the Eastern Goldfields, Roebourne reverted to being a service town for the pastoral industry. For a time it also served areas being developed in the Kimberley region to the north, but the new ports at Derby and Broome from 1884 reduced Roebourne's importance to that area. Eventually four local government areas were established in the region. Roebourne continued as the administrative centre for the Shire of Roebourne until the shire's offices were relocated to Karratha in 1975.

Marble Bar became the centre for gold mining. Its population grew to over 5000 during the gold boom, but is now around 200. The town of Onslow was established in 1885 and became an important port for the export of wool. It was relocated in 1925 following a major cyclone and has recently experienced growth as a hub for new gas development projects. The small fishing town of Point Samson also dates from the 1880s. It was also used for shipping blue asbestos from Wittenoom until the 1960s.

Port Hedland was established in the 1890s, initially as a wool port. It was originally named by Captain Peter Hedland in 1863 as Mangrove Harbour. Roebourne remained the main coastal centre in the Pilbara until a narrow-gauge railway was built from Marble Bar to Port Hedland in 1912. Today the main centres are the town of Port Hedland and the city of Karratha.

With the development of iron ore mining since the 1960s, several new towns have been established in the Pilbara, namely Dampier, Karratha, Newman, Paraburdoo, Tom Price and Wickham. Others such as Goldsworthy and Shay Gap were built to house mine workers and their families and have since been closed when no longer needed. Port Hedland and Karratha now have populations exceeding 15,000 and 20,000 respectively. In addition to its role in the iron ore industry, Karratha has also been the land base for the North West Shelf oil and gas projects since the 1980s.

150 years after the first European explorers and settlers the Pilbara is now a major mining province and the home of more than 60,000 people. In addition to the mining, processing and export of iron ore and other minerals, the region also produces oil and natural gas, salt, liquid ammonia and ammonium nitrate. It continues to support sheep and cattle grazing as well as fishing, aquaculture and tourism. It also hosts Australia's largest port by tonnage shipped, Port Hedland, and has the country's largest privately-owned railway network and the world's heaviest and longest regularly-scheduled trains.

7 HISTORY OF IRON ORE MINING IN THE PILBARA

Beginnings

The first report of iron ore in the Pilbara was made by Francis Gregory, having discovered some during his 1861 explorations. Its existence was confirmed by government geologists H P Woodward in 1890 and Gibb Maitland in 1919. Woodward noted that "iron ore occurs in immense lodes" in the inland Pilbara, and "there is enough to supply the whole world should present supplies run out … but as iron ores are of no value it is useless to trouble about them" (RRIA Reflections). Iron ore had also been discovered in 1880 on Koolan and Cockatoo islands further north near Derby. However due mainly to the availability of large deposits on the Eyre Peninsula in South Australia, no mining of the ore in WA took place until the 1940s. The SA ore had been mined since the 1870s, and iron and steel production had taken place in Whyalla and later in Newcastle and Port Kembla.

The first iron ore mines in WA were on Koolan and Cockatoo Islands, commencing in the 1950s, with the ore being processed in a charcoal iron plant at Wundowie in WA. Iron ore was also mined from the 1960s at Koolyanobbing, originally for processing in a blast furnace at Kwinana and later being shipped for export through the port of Esperance. Initial operation of the Wundowie plant also used small quantities of ore from Koolyanobbing and Wundowie.

In 1938 the Commonwealth Government placed a ban on the export of iron ore following its classification as a strategic material. The ban was continued after the war, due to the Government's belief that Australia's iron ore resources were limited. At the same time the WA State Government was not allowing the pegging of any claims over iron ore deposits. In 1960 the export ban was relaxed, and the restriction on pegging claims was removed in 1961.

Goldsworthy Mining Associates

In the Pilbara the first significant deposit to be developed was at Mt Goldsworthy, on Pardoo Station. A preliminary survey was made by Geological Survey geologists in 1938 and assessed in more detail in the 1950s. In 1962 Mount Goldsworthy Mining Associates was formed by a consortium consisting of Consolidated Goldfields Australia of Sydney, Cyprus Mines Corporation of Los Angeles and Utah Development Corporation of San Francisco. The joint venturers formed a new company, Goldsworthy Mining Ltd, as the operating company. In 1991 Goldsworthy Mining Associates and Mount Newman Mining were absorbed into the BHP Iron Ore group.

In 1963 the consortium was granted an export licence to ship 4 million tons of iron ore annually from a port to be built at Finucane Island, Port Hedland. In February 1965 a contract was signed with Japanese steel mills and construction of a port, the town of Goldsworthy and a connecting railway was undertaken. The first rail delivery to the port was made on 1 December 1965. The first shipment of ore was loaded onto the Harvey S Mudd in June 1966.

Mining continued at Mt Goldsworthy until 1982, when the mine was closed. In the meantime the company had commenced mining at Shay Gap to the east in 1973, where a town of the same name had been established along with a railway extension. Mining here continued until 1993. Following closure of the mines both towns were abandoned after the demolition or removal of the buildings

and rehabilitation of the area. In 1993 the Yarrie mine was opened 25 km further to the east. It continued operating until 2014, when it was placed on a care and maintenance basis. Other mines operated in the same area were Nimingarra and Sunrise Hill.

Hancock Prospecting

In 1952 Lang Hancock, then managing Mulga Downs Station, while flying his light plane became aware of possible iron ore deposits in the Hamersley Range. He investigated the area with the prospector Ken McCamey and found there were indeed very extensive deposits of iron ore. Through his company Hancock Prospecting Pty Ltd (HPPL), he formed a partnership with his friend Peter Wright's company, Wright Prospecting Pty Ltd (WPPL), with the objective of developing the discoveries. The partnership undertook further exploration and mapping, and sought to interest major steel mills and mining companies in investing in the Pilbara discoveries.

Following the removal of restrictions on pegging of claims and export, the partnership was granted mining tenements over extensive areas. HPPL and WPPL negotiated various agreements with Rio Tinto for the development of iron ore resources. Over time several mines have been developed under these agreements, with HPPL and WPPL receiving royalties from the companies undertaking the mining, processing and export.

The first mine in which HPPL was directly involved as an owner was at Hope Downs, after the company secured a State Agreement for the Hope Downs tenements in 1992. Detailed exploration and evaluation work followed and attempts were made to engage partners to develop the resource. Eventually in 2005 a 50/50 joint venture with Rio Tinto was formed, with Rio Tinto being the operator. The first Hope Downs mine was developed, along with a railway connecting with Rio Tinto's existing network, and the first ore was railed to Dampier in December 2007.

In May 2014 mining of iron ore commenced at the Roy Hill mine south of Port Hedland. The lease for this site was pegged by HPPL in 1992 and the mine is the first to be operated directly by the company. It is 70% owned by HPPL, with smaller shares owned by Japanese, South Korean and Chinese interests. A railway to Port Hedland was constructed, with the first export shipment of iron ore planned for September 2015.

Hamersley Iron

In 1962 the Rio Tinto Zinc Corporation was formed in the UK by the merger of the Rio Tinto Company and the Consolidated Zinc Corporation. At the same time Conzinc Riotinto Australia (CRA) was formed. In September of that year two CRA geologists, Bill Burns and Ian Whitcher, identified the large, high-grade deposits of iron ore in the Hamersley Ranges in what later became known as Mt Tom Price (named after the engineer who was vice-president of Kaiser Steel). In 1966 Hamersley Iron (HI) was formed as a joint venture between CRA and Kaiser Steel.

HI undertook development of the Mt Tom Price mine as the first mine in the Hamersley area. The first shipment of ore left for Japan in August 1966.

In the Pilbara, Rio Tinto now wholly own Hamersley Iron's eight mines and also operate the Hope Downs mine (50:50 joint venture between Rio Tinto and Hancock Prospecting Pty Limited), the Channar mine (Rio Tinto: 60 per cent) and the Eastern Range mine (Rio Tinto: 54 per cent). The

company's iron ore operations in the Pilbara also include Robe River Iron Associates' three mines, in which it has a 53 per cent interest. These are Mesa J, Mesa A/Warramboo and West Angelas.

Mount Newman Mining

While looking for manganese in the Mt Newman region in 1957 the WA prospector A S "Stan" Hilditch noticed outcropping iron ore on the western end of Mt Whaleback. Samples sent to engineer C H Warman in Sydney assayed at 68.8% iron. When the embargo on the export of iron ore was lifted in 1960 the pair staked claims to the area. In 1963 AMAX Inc of the US formed Mt Newman Iron Ore Company Ltd and signed an options agreement with Warman and Hilditch. A joint venture was formed and in 1967 Mt Newman Mining Co Pty Ltd was formed as a wholly-owned subsidiary of BHP to manage the project on behalf of the joint venturers.

BHP Billiton's operations in the Pilbara now comprise a complex integrated system of seven inland mining operations, more than 1,000km of rail, stock yards and two separate port facilities located in Port Hedland. These operations are owned or part-owned through a number of joint venture arrangements. Mining operations are supported by the town of Newman, while Port Hedland is the location of the company's port and rail facilities at Nelson Point and Finucane Island.

The Mt Whaleback mine, established in 1968, is the biggest single-pit open-cut iron ore mine in the world, being more than five km long and nearly 1.5 km wide. Adjacent are smaller deposits, Orebodies 29, 30 and 35. Smaller satellite mines – Wheelarra and Orebodies 18, 23, 24 and 25 – are located outside the town of Newman. The Yandi and Area C mines are located about 100 kilometres north-west of Newman. The Yarrie mine, which is 200 kilometres east of Port Hedland, ceased production in 2014. Jimblebar mine, 40km east of Newman, was commissioned in April 2014.

Robe River Iron Associates

In 1962 Basic Minerals Pty Ltd, founded by Garrick (later Sir Garrick) Agnew, obtained an option over ore resources in the Robe River region and a right of occupancy permit from the WA Government. In the same year Agnew arranged for representatives of Cleveland Cliffs Iron Corporation (CCIC) to visit the area and consider involvement in developing the resources. In 1964 CCIC bought all the shares in Basic Minerals. A new company Cliffs Western Australia Mining Company Pty Ltd (CWAM) was formed and a feasibility study for a mining project was started. In 1967 CWAM engaged Bechtel Pacific Corporation of San Francisco to prepare a detailed overall planning proposal. The first ore sales contract was signed with Japanese steel mills in 1969. At the time this was the world's largest single iron ore sales contract.

Robe River Iron Associates (RRIA) was formed as a joint venture to develop, manage and operate the project. This involved five companies, representing Australian, American and Japanese interests. Rio Tinto is the majority owner with 53% of the joint venture. Construction began in 1970 of a mine, railway, processing plant, port facilities, power generating plants and the towns of Pannawonica and Wickham. It was claimed that this involved the largest initial investment of any of the mining projects in the Pilbara.

Pilbara Iron was formed in 2004 as a wholly owned subsidiary of Rio Tinto to manage assets of Hamersley Iron and RRIA, including the two groups' railway systems. This followed a period since 2001 when operation of the railways had been merged under Pilbara Railways, which in turn was

folded into Pilbara Iron in 2005. Whilst the various operations have been merged, each company retains ownership of, and profits from, their respective mines and infrastructure, and continues to control its own mineral resources.

Fortescue Metals Group

Fortescue Metals Group Ltd (FMG) was formed in 2003. Construction of the port, rail and mine project commenced in February 2006 with work on the company's Herb Elliott Port site at Anderson Point, Port Hedland. The first mine is at Cloudbreak, which was followed by Christmas Creek. These are both south of Port Hedland and are known as the Chichester Hub. Further mines were opened at the Solomon Hub 120 km west of the Chichester Hub. These are the Firetail mine and the Kings mine. Ore production commenced here in 2012 and 2014 respectively. FMG developed railways to serve the four mines, totalling 439 km in length.

Other Companies

Other companies operating or planning iron ore mines and export facilities in the Pilbara include Atlas Iron, BC Iron, CITIC Limited and Aquila Resources.

8 DESCRIPTION OF THE ORIGINAL PILBARA HEAVY HAUL RAILWAYS

Overview

The Pilbara heavy haul railways service mines spread over a large area. This proposal for engineering heritage recognition is based on the earliest of the railways, whose development pioneered the way for those that followed. The initial railways have been upgraded and extended over time, and new railways have been constructed in recent years or are in advanced stages of planning.

The remote area, hostile climate and lack of prior experience in designing and constructing major engineering works in this region meant that many difficulties had to be overcome in the early days. Problems were solved and standards set, and significant research was carried out to assist in the design and construction of the railways. While various improvements were made over time, and engineering in subsequent projects has continued to evolve, the early projects were of high quality. In the main they continue to operate reliably and safely and are a vital part of the iron ore mining and export industry.

Railroad bridge over Fortescue River, 1972

The original heavy haul railways dating from the 1960s and 1970s are the Goldsworthy and Mount Newman railways now operated by BHP Billiton, and the Hamersley and Robe River railways now operated by Rio Tinto. Various branches and extensions have been added to these over the years to reach new mines as they were established. The BHP Billiton systems terminate in Port Hedland, while the Rio Tinto systems connect to Dampier and Cape Lambert ports.

All the Pilbara iron ore railways are standard gauge, or 1435 mm (4 ft 8 ½ in). The first long railway in the region was the 1067 mm (3 ft 6 in) gauge railway from Marble Bar to Port Hedland, known unofficially as the Spinifex Express. This was 183 km in length and was opened in 1912 to service the goldfields and pastoral stations. From the1880s several other short, narrow gauge railways or tramways were built to serve copper and asbestos mines and the various small ports being developed in the area. These were mainly 610mm (2 ft 0 in) gauge. All have since been closed.

Construction of the post-1960 railways was undertaken largely by American and Australian contracting companies. There was initially a lack of Australian contractors experienced in track laying, given that most of the existing railway tracks to that time had been constructed by governments using their own personnel. Once built, the railways were maintained mainly in-house by the mining companies. This has also changed, with maintenance contractors now carrying out much of this work.

A significant role in the construction of the original heavy haul railways was played by workers from Thursday Island and other Torres Strait islands. Residents of these islands had been engaged on the national standard gauge railway from Fremantle to Kalgoorlie and on narrow gauge railways in Queensland, and had proved to be highly skilled and productive tracklaying workers. Large numbers were recruited to work for the rail contractors in the Pilbara. In May 1968 on the Mt Newman railway project, workers contracted to Morrison-Knudsen-Mannix –Oman (MKMO) broke the world tracklaying record. In one day they laid, anchored and spiked 4.35 miles (about 7km) of track, breaking the previous record of 2.88 miles (4.6km) set in the US in 1962. The feat was attributed to the talents of MKMO's engineers in developing specialised machinery and techniques and the skills of the crew, many of whom were islanders. In September 2012 a statue was unveiled in Port Hedland to recognise the record and honour the Torres Strait Islanders who took part.

Thursday Islanders laying track 1965/6

Goldsworthy Railway

Construction of the Goldsworthy railway commenced in 1965 and it opened in May 1966. It was built to link the Mount Goldsworthy mine to Finucane Island, where a port was built on the western side of Port Hedland harbour. The port is connected to the mainland by a 5.6km causeway across West Creek. The original line was 112 km long. It was built as a standard gauge railway, as are all the other heavy haul lines in the Pilbara. The line was extended to Shay Gap in 1972 and to Yarrie mine in 1993. The total length is now 208 km. The future of the railway will depend largely on whether the Yarrie mine reopens.

The standard gauge track was laid with more than 12,000 tonnes of 50.4 kg/m rail on some 180,000 WA hardwood sleepers. Crushed jaspilite rock was used as ballast with a depth of 127mm. Similar rail was used for the Shay Gap extension, with the ballast depth being increased to 203mm. The maximum grade between Goldsworthy and Finucane Island is 0.33% against loaded trains and 0.66% against empty trains. The line traverses mainly flat country with several significant river crossings. These included bridges on the De Grey and Strelley Rivers and Tabba Tabba and West Creeks. The De Grey bridge is the longest at 294.1m. A further five watercourses were crossed by low embankments with culvert systems. However flows from heavy cyclonic rains during the 1966-67 wet season overtopped the railway and damaged the track, causing excessive delays to traffic. Embankments were replaced with additional bridges to minimise recurrences.

From Shay Gap to Goldsworthy the maximum grades are 0.64% against loaded trains and 1.04% against empty ones. There are two bridges in this section.

The original railway track was constructed by a company set up by an American contractor, Franco Railroad Contractors (Aust.) Pty Ltd. Utah Development, one of the partners in the Goldsworthy Mining Associates consortium, constructed the earthworks and bridges. Thursday Islanders were recruited for work on tracklaying. The contractor for the extension to Shay Gap was Fluor Australia.

The first two locomotives were 640kW diesel electric locomotives, manufactured by the English Electric Company of Australia at their Rocklea, Queensland plant. These were initially used for construction work and early haulage of ore. Three larger locomotives, each rated at 1453kW, were then procured from the same source. All five were delivered between 1965 and 1967. Additional locomotives were ordered over time, including two in 1971 to allow for extra duty with the Shay Gap extension to the railway. By 1972 a total of eight locomotives were in service. Each train was hauled by a single locomotive. The larger locomotives could haul 60 loaded cars while the smaller ones hauled up to 30 cars.

Between 1965 and 1970, 234 ore cars designed by AE Goodwin Ltd were built for Goldsworthy by Tomlinson Steel Ltd of WA and Scotts of Ipswich Pty Ltd of Queensland. These weighed 22 tonnes empty and had a capacity of 74.1 tonnes each. In addition the company had various other items of rolling stock, mainly for use in track maintenance and embankment repair. These included tank cars for water carriage, flat cars, box cars, side dump cars and ballast cars. Except for the side dump cars, all were manufactured in Australia. Three fuel tank cars owned by BP Australia also used the track. These were manufactured by Tomlinson Steel and Commonwealth Engineering Pty Ltd.

The railway was operated by a radio controlled system, with the controller located at Goldsworthy. The railway's administrative centre and main workshops were also located there. The operation was based on a continuous three-train system, with timing governed by the rates of loading and unloading. Automatic signals were installed to protect a diamond crossing outside Port Hedland where the track crosses the Mt Newman railway. A joint working arrangement between the two railway systems was in place to manage train movements at the crossing.

Ore was loaded at Shay Gap and Goldsworthy through loading bins with a capacity of 200 tonnes, under which the trains passed. One car at a time was loaded, with a capacity of 3000 tonnes per hour. Unloading on Finucane Island was through the bottom discharge openings into a concrete

hopper beneath the car. During August 1978 the system was transporting an average of 21,205 wet tonnes of ore per day.

Hamersley Railway

The first section of the Hamersley Iron railway system was built linking Mt Tom Price with a stockpile area and wharf at Parker Point, Dampier, a distance of 292 km. This was begun in September 1965. The first ore train ran in June 1966 and the railway was officially opened by Charles (later Sir Charles) Court on 1 July 1966. A 94 km extension from Mt Tom Price to Paraburdoo was completed in March 1972. The railway is mostly single track, with passing loops spaced at approximately 20 km intervals. Train speeds were between 65 and 80 km/h.

Central Engineering Services Pty Ltd (CES) was appointed overall construction manager for the mine and infrastructure development. CES was the engineering arm of Conzinc Rio Tinto Australia and later became Minenco Pty Ltd. A contract for construction of the railway was awarded to Morrison-Knudson-Mannix-McDonald, an American, Canadian and Australian joint venture.

Design criteria for the railway were set in 1962 for haulage of 8 Mgt/y (million gross tonnes per year) expandable to 16 Mgt/y. North American design standards were adopted, following Association of American Railroads (AAR) criteria in terms of locomotives and rolling stock and American Railway Engineering Association (AREA) criteria in terms of track. The maximum grade against loaded trains was 0.33% between Dampier and Tom Price and 0.42% to Paraburdoo, and 2.0% against empty trains. Horizontal curves were a minimum of 391m and a maximum of 3050m on the Tom Price section and 914m and 3048m respectively on the Paraburdoo section. A standard axle load of 30 t was adopted, using 59 km/m rail laid on untreated hardwood sleepers with dimensions 230mm x 150mm x 2440 mm. Sleepers were spaced at 495mm on 200mm of 50mm size crushed stone ballast. The 18.3m rails were flashbutt welded into 0.4km strings, which were mechanically jointed.

Rapid growth in demand and production meant that between 1966 and 1975 traffic increased to 56 Mgt/y. A major program of rail and sleeper renewal was undertaken during that period. The original mainline 59 kg/m rail was replaced with 68 kg/m rail and the ballast depth was increased to 300mm. Hardwood sleepers were replaced with concrete sleepers. A measured rail temperature range of 0°C to 75°C affected track stability. Research was carried out into the causes of derailments and the means of preventing or minimising them. Causes were associated with train dynamics or track quality or a combination of both. Technical issues involving loads, stresses and fatigue in rail, wheel and axle systems, track profile and alignment were studied. In addition methods of train handling were examined.

Research and development carried out by and for Hamersley and Mount Newman Mining during the early years covered many aspects of railway operations. These led to high levels of safety, productivity and reliability, along with reductions in costs. One example is the reduction in derailment costs. During the first eleven years of operation, which included the significant capacity expansion mentioned, derailment repairs added an average of 11.3% to HI's railway annual operating costs. By the end of this period the cost had fallen to 1.3% of annual costs.

Hamersley train on causeway at Dampier 1966

Other modifications were carried out to railway embankments and other components to improve the performance of the railway and reduce operating and maintenance costs. Limited rainfall and streamflow data for the region existed prior to design, and the requirements for culvert and waterway design had been underestimated. Cyclone Shirley occurred during construction in April 1967 and caused considerable damage to earthworks and culverts, and in December 1975 Cyclone Joan caused further damage. Remedial measures were taken and improved design criteria adopted for new and reconstructed works.

Mount Newman Railway

The Mount Newman railway connects the Mount Whaleback mine with the port at Nelson Point, Port Hedland. The 426 km heavy duty standard gauge line was officially opened on 22 January 1969.

Bechtel Pacific Corp. of San Francisco was appointed construction administrator for the overall mining development project. The American-Canadian joint venture Morrison-Knudson-Mannix-Oman was awarded the railway construction contract. In 1970 MKMO received a Construction Achievement Award from the Australian Federation of Construction Contractors for building the railway ahead of schedule, and for establishing a world track-laying record.

The line was built with 440m lengths of 66kg/m rail, which was the heaviest then used in Australia. The rail was originally laid on WA jarrah sleepers at 533mm centres. A total of 63,000 tonnes of rail, 870,000 sleepers and 600,000 m^3 of high grade granite ballast were used. The minimum main line curve was 582m radius. The steepest grade against a loaded train was 0.55 per cent, fully compensated for curves, and 1.5 per cent for empty trains. The system included 16 passing sidings, each 3000 m in length, and with 600m back tracks. With yard sidings, mine loops and marshalling tracks the total length of track was 547km.

When loaded, the trains head through the Ophthalmia Range at Ethel Gorge, travel westwards along the Fortescue Valley for 145 km, and then swing north into the Chichester Range. Here the trains climb 91m in 26km before levelling out onto the coastal plain for the remaining 185 km to the port.

The initial rated capacity of the line was 40 million tonnes of ore per year. Typically six trains per day were scheduled with the outward journey from the mine taking some 8 hours and the total return trip about 20 hours. Trains were operated to a maximum speed of 75 km per hour.

Two modes of train configuration were used, depending on varying operational requirements. In one, the train consisted of 180 loaded cars drawn by three 2680kw Alco diesel-electric locomotives. Two extra locomotives were used to bank the train over the steep grades of the Chichester Ranges. The total mass of each train was some 23,000 tonnes, of which 18,500 tonnes was payload. The other mode was a Locontrol train, consisting of 3 lead locomotives, 150 ore cars, 2 remote locomotives, 1 control car and 90 trailing cars. This train had a payload of some 25,000 tonnes. The Locontrol electronic system, developed by GE Transportation, provides precise automatic control of the power distribution among locomotives distributed along the train, and reports the status of each locomotive to the driver at the head of the train.

At the Newman end the trains are filled through loading tunnels. At the port area trains are split into separate rakes and the locomotives uncoupled and taken for service. Each rake of cars is moved through the car dumper using a winching system. A compressor car set is attached to the rear of each rake to control the braking system.

The information in this section is based on operations during the 1970s and 1980s. Various changes and upgrades have been made over the years, but these details indicate the scope of the project in its early days. Trains more than 3.5 km long now routinely haul more than 200-300 cars and 20-30,000 tons of iron ore. In 2001 a BHP Billiton train set a world record for the heaviest train by hauling a total of 99,734 tons for 275km between Yandicoogina and Port Hedland. The train consisted of 682 wagons and 8 locomotives and was 7.3km long.

Robe River Railway

Following approval for the Robe River mine development on 1 July 1970, Morrison-Knudson-Mannix-Oman (MKMO) were awarded a contract to construct the railway from Cape Lambert to Pannawonica. The railway consisted of a standard gauge track 168 km long, running from RRIA's mine site at Eastern Deepdale near Pannawonica to the port and processing facilities at Cape Lambert. The track was completed in May 1971. A test train hauling ore ran to Cape Lambert on 6 July 1972 and the first official production ore train ran on 8 August. This train consisted of 75 cars hauled by two locomotives. In line with an ancient mining tradition the first car travelled with a tree planted in the ore. This is said to signify the gladness of miners at the opening of a new mine.

First train from Pannawonica – 8 August 1972

Bechtel was appointed to undertake detailed overall planning of the mining development project. The WA consulting firm Halpern Glick and Lewis prepared initial plans for the railway. MKMO was appointed the main railway contractor. Other contracts included those by WA firms Bell Bros, who carried out track grading and rock removal, and Bunnings who supplied 360,000 wooden sleepers.

The track was designed to carry axle loads of 31 tonnes. Rails were 67.5 kg/m, welded into 454.8 m lengths. The track crossed five steel bridges and one flyover across the Hamersley railway some 74 km from Cape Lambert. Ruling grades were set at 0.5% against loaded trains and 1.3% against empty trains. Most of the line was single track, with three main sidings to allow for train crossings. Typical train operations consisted of three locomotives and 135 ore cars. The railway did not have fixed signals, with safe working being by voice indications. Traffic instructions were given to drivers. These were taken down in writing and relayed back to controllers before orders were given to proceed.

The first two locomotives for the Robe River railway were reconditioned 1190 kW diesel-electric units previously used on the NSW Government Railways. One had earlier served as part of the Royal Train during the 1954 royal visit to NSW. They were built by the Montreal Locomotive Works, Canada. For Robe they were used on construction work and later for shunting at the mine load-out. After retirement from service in 1979, one locomotive was donated to the Pilbara Railways Historical Society and one to the Wickham Lions Club for display purposes.

In 1971 an order was placed with A E Goodwin for five Alco M-636 2684 kW locomotives. These were delivered between August 1971 and the following January, and a further one was ordered in October 1972. When an accident required one of these locomotives to be rebuilt Robe River purchased a further new M-636 from Hamersley Iron to meet supply commitments. A surge in demand in 1974 caused Robe to purchase four second-hand 2240kW locomotives from the United States, as Australian companies were unable to meet the short time-frame required by Robe. Two more M-636 locomotives were obtained from Commonwealth Engineering in 1977.

The initial contract for supply of cars was for 285 ore cars and 40 ore/ballast cars, each of 101.6 tonnes capacity. These were supplied by the Nippon Sharyo company of Japan. Subsequent contracts for ore cars were awarded to Tomlinson Steel Ltd of WA. By August 1978 the system had a total of 721 ore cars. The inventory also included a number of flat cars, dummy compressor cars and fuel tank cars, as well as specialised machines and equipment for maintenance.

Cutting under construction on the Robe River railway, 1972

Subsequent Railway Developments

As described, all the original railways have been upgraded and extended over the years. In addition several new railways have been constructed or planned.

In 2007-08 a new 280 km railway was developed by Fortescue Metals Group from its Cloudbreak mine to Herb Elliott Port at Port Hedland. This was later extended by 50 km to Christmas Creek mine. A 129 km branch from the main line to Firetail and King's Valley mines at FMG's Solomon hub was opened in 2012. In 2014-15 a new independent railway 344 km long from Port Hedland to the Roy Hill mine was constructed by the Hancock Prospecting group. Forward planning is under way by Aquila Resources for a separate railway to a new port at Anketell near Dampier. Iron ore produced by smaller mining companies is also shipped to port by road haulage, while CITIC Pacific pumps iron ore in the form of a slurry though a 30 km pipeline to its port at Cape Preston.

Several unsuccessful attempts have been made through tribunal and court hearings to obtain access for other companies to BHP Billiton's and Rio Tinto's railways. In particular FMG proposed to use existing railways but was obliged to provide their own. The FMG railways are open to other users, subject to appropriate agreements. Under a joint venture arrangement the FMG subsidiary The Pilbara Infrastructure Pty Ltd provides rail haulage and port services to BC Iron for production from its Nullagine mine some 50 km north of Christmas Creek mine. Hancock Prospecting could not obtain FMG's agreement to use its railway to serve HPPL's Roy Hill mine, so has built its own railway. In part this runs parallel to BHP's and FMG's railways, and deviates around FMG's tenements as it was unable to obtain agreement to traverse them.

9 ASSESSMENT OF HERITAGE SIGNIFICANCE

Historical Significance

The heavy haul railways are an essential part of the development of iron ore production in the Pilbara, which is also of historical significance to Western Australia and Australia as a whole. This was the first large scale industrial development in the Pilbara. It was also the start of a major export industry that has been of great economic importance to the country. It has been the catalyst for the development of new towns and ports and led to large increases in population and local economic activity.

The first mining and railway developments relied to a significant extent on Japanese and United States inputs. Export contracts with Japanese steel mills were the stimulus for commencing mining, and Japanese investment was an essential part of the funding for the first projects. This gave rise to some of the earliest Australian business relationships with Japan since before World War 2, and these have continued to today. In recent years Chinese investments in mines and orders for iron ore have come to the fore, but the industry's role in developing a strong relationship with Japan remains of historical significance.

Early US involvement consisted of investment in mining, and the provision of expertise in the construction and operation of heavy haul railways. The latter included the winning of construction contracts by US companies and assistance given by US train drivers who had been working on construction trains. This included training in long, heavy train handling given to mining company drivers recruited from the state government railway systems, whose prior experience had been limited to smaller trains. This laid the foundation for ongoing cooperation between railway practitioners in the two countries.

Creative or Technical Achievement

At the time of planning the first heavy haul railways in the Pilbara, trains operating on Australian railway systems greater than 2,000 tonnes in mass were rare. Most systems were owned and operated by state governments and much of their design and construction work was done in house. Opening up the major iron ore mining province in Australia's remote north-west required action to obtain and develop expertise and knowledge in heavy haul railway engineering, and in the safe and economical operation of long, heavy trains. That the early systems were successfully developed over short time frames and formed the basis of today's world-leading Pilbara railways is a significant achievement.

Operation of the original railways was not without problems, some of which have been mentioned earlier. The early years experienced marked expansions in terms of tonnages hauled to levels well beyond the original design criteria. For example between 1966 and 1975 annual traffic on the Hamersley railway increased from 9 million gross tonnes to 56 million, while on the Mt Newman railway between 1969 and 1975 the traffic increased from 11 million gross tonnes to 52 million. These loadings led to track and vehicle deterioration at much higher rates than predicted by extrapolation from the experience of other railways operating at lower axle loads and annual tonnages. Solving of track and vehicle deterioration issues has enabled further capacity increases,

such that in 2014 Rio Tinto had plans for expansion of production to 360 million tonnes per year, while BHP Billiton plans an increase to 270 million tonnes per year. In July 2014 BHPB exported its one billionth tonne of iron ore to Japan since the first shipment in 1969.

These and other issues led the companies in 1973 to embark on a research programme. Whilst it is commonplace for engineers and scientists to share knowledge and research results after the event through conference presentations and published papers, it is noteworthy that the commercial rivals Mt Newman Mining and Hamersley Iron agreed to a collaborative programme of research that would benefit both companies and avoid duplication. The work was mainly carried out by BHP's Melbourne Research Laboratories and the University of Western Australia, and later by ACE-T Pty Ltd, a company formed by members of the UWA group working on heavy haul train dynamics. The programme resulted in significant increases in operational efficiency and cost-effectiveness. The research was notable for its integration of laboratory studies and field investigations. This ensured that the laboratory staff gained a better appreciation of testing under field conditions rather than under controlled laboratory conditions. It also included a structure and management arrangements that allowed the involvement and cooperation of track maintenance personnel with research staff.

The programme contributed both to immediate or short-term problem-solving, and also to longer term strategic decisions related to planning of the mining developments and operation of the railways.

Computer simulation was used in a number of areas at a time when computers had limited capacity and computing time was expensive. Worldwide there was little experience in the design and operation of such long, heavy ore trains and much work was done with the aim of improving the performance and longevity of train and locomotive components. Benefits included better safety and more efficient operations with less downtime and lower costs. Initial simulation studies were in the area of longitudinal dynamics of trains. These led into other areas of train performance and locomotive dynamics.

Examples of research leading to economic benefits include coupling systems, driver practices, wheel management, track maintenance management, man management and information systems management. In 1979-80 the average wheel life for MNM trains was 340,000 km. By 1984 the average life was approaching 1 million km. This resulted from improved wheel profiles, a rail grinding programme and improved machining practices, all resulting from research under the programme. Research into improved wheel materials was also carried out. Over a period of 5 years a 12% reduction in fuel costs was achieved through a number of initiatives to improve train performance. These included improved locomotive maintenance, free-wheeling, train handling, higher axle loads and banking. Improvements to track maintenance included appropriate techniques in profile grinding, head-hardened rail in curves, better techniques to predict rail life and more advanced rail management strategies.

These measures led to the adoption of further increases in allowable axle loads and greater system economies. With the introduction of the various improvements in materials and techniques the numbers of permanent way maintenance personnel was able to be significantly reduced. More recent advances have led to many other changes, not the least of which is the remote control of trains.

Accompanying these improvements was an increased use of computers for compiling data bases and statistical analysis of operational data including cost analysis. This led to the identification of critical areas where operational effectiveness could be improved by further research activities.

The research and innovation carried out for the Pilbara railways was not done in isolation from other railway systems and the knowledge and experience of their developers and operators. However the intensive efforts put into the Pilbara systems led to a substantial body of knowledge and experience directly applicable to the region and the operational requirements of the mining companies. This contributed significantly to the major increases in tonnages being moved with continuing cost-effectiveness.

It is significant that the first international conference on heavy haul railways was held in Perth, WA in 1978, which followed the period of intensive initial development of the four Pilbara railways. A wide range of railway professionals and other interested people from Australia and overseas attended, including engineers, scientists, economists, manufacturers and business management personnel. The conference was organised by The Institution of Engineers Australia and The Australasian Institute of Mining and Metallurgy. It was sponsored by Cliffs Robe River Iron Associates, Goldsworthy Mining Ltd, Hamersley Iron Pty Ltd, Mt Newman Mining Company Pty Ltd and Westrail. Among the many technical papers presented from around the world, about one third were by staff of the Pilbara companies, the BHP Melbourne Research Laboratories or the University of WA. This event demonstrates the international interest in, and significance of, what was being done at that time in the Pilbara and associated research establishments.

Further evidence of the international status of the Pilbara railways has been reported in a paper by William Walker (listed in Section 15): “The Pilbara railways are unique for a number of reasons. One of the most important is that, unlike other Australian railways, they are vertically integrated with the mining and port infrastructures. The Australian Bureau of Agriculture and Resource Economics (ABARE) in a report in June 2006 on export infrastructure and access, commented that ‘the Pilbara iron ore export chains stand out for the way that mine production, transport, cargo assembly and blending, loading and shipping are integrated.’ The major advantage of this is that they are very responsive to fluctuations in demand.

“Mining companies from around the world, including the USA, Canada, Liberia, Sweden, China and Brazil have made technical visits to view the Pilbara railway operations and equipment. The largest iron ore company in the world, the Brazilian CVRD (VALE), while they were constructing a railroad through the Amazon Jungle to their new Carajas mine, sent railroad officials and engineers a number of times. Asked why they visited the Pilbara so often, they replied that they were going to build an Australian railroad in the jungle”.

Walker also quotes a study by consultants Travers Morgan in 1994 that benchmarked the Pilbara railways against other Australian railways and 23 US Class I and regional railroads. Measured in net tons per route-km in 1992-1993, the Mt Newman and Hamersley railways carried over four times the load of the highest of the other railways.

Social or Cultural Significance

The development of iron ore mining in the Pilbara has had a profound effect on the social and cultural environment of the region. As described earlier, from a sparsely populated area given to pastoral activities, gold mining, fishing and traditional Aboriginal living, the region now has major mining infrastructure spread over wide areas, new and expanded towns, and a considerably larger population with a wider range of employment. Early changes took place during the construction phase, with the arrival of large numbers of workers and the setting up of temporary accommodation. Thursday Islanders played an important part in railway construction, along with people from all parts of Australia and overseas. Subsequently the mining companies have developed programmes for Aboriginal training and employment.

While it is not possible to single out the heavy haul railways as the main driver for these changes, it is evident that the development of the iron ore mining industry there would not have been possible without the railways. They can therefore be considered as important contributors to the region's changed social and cultural environment.

Rarity

The original railways paved the way for the major networks now operating and still being augmented. At the time of their development they were at the forefront of heavy haul railway technology, and were associated with important laboratory and field research. They were the first heavy haul, standard gauge railways in Australia. At the time they could have been considered rare examples of their kind, and are still world leaders in this field.

Integrity or Intactness

The original railways have been upgraded and extended but are still operating as intended 50 years later. As part of the mining industry's essential infrastructure they will continue to be operated and maintained as long as the mines they serve continue in production. With the current level of proven reserves and production this is likely to be for many decades.

10 EMINENT PERSONS ASSOCIATED WITH THE PROJECT

Many people contributed to the initiation and development of the iron ore mining industry in the Pilbara and the railways that form an essential part of it. The vital contributions of the many in the mining companies, contractors, consultants, manufacturers and government agencies who carried out the work are acknowledged. A few of the more prominent individuals whose roles were critical to establishing the Hamersley and Robe River projects are mentioned in this section.

Sir Charles Court (1911-2007) was one of the most influential persons in the development of the Pilbara industry. In a long career in public life his state government positions included Minister for Industrial Development and the North West 1959-71; Minister for Railways 1959-67; and Minister for Transport 1965-66. Among many awards and honours he was knighted in 1972 for his contribution to state and national development. He served as Premier of Western Australia from 1974 to 1982.

Court has described how he and **Sir David Brand**, who became Premier of WA in 1959 and was knighted in 1969, before they were in government decided that one of their main objectives was to change the status of WA from being a mendicant state to one with its own source of income. They decided that iron ore mining was the way to do this, once the embargo on export was lifted. They also reached the conclusion that the Commonwealth Government would not provide the capital for the necessary infrastructure and the mining companies would have to build and operate the infrastructure, including the railways.

Court saw to it that the agreements drawn up with the Pilbara mining companies ensured the railways would be built to standard gauge. This policy stemmed in part from his experience during World War II when he was given the task of moving by rail a division of tanks and other vehicles from NSW and Victoria to WA and back again. The inefficiencies caused by multiple railway gauges convinced him of the need to specify a single gauge and he settled on standard gauge. Another lesson he learned during his time as Minister for Railways was that many governments insist that railways be common carriers, and that this can be a major cause of inefficiencies. Court determined that the Pilbara railways would not be common carriers. This allowed the companies to build and operate the railways that suited their own requirements, and led to the development of what are regarded as world exemplars of bulk rail operations.

L F G "Lang" Hancock (1909-1992) was influential in getting development in the Pilbara started. He has already been mentioned for his part in identifying and pegging iron ore deposits in the Pilbara, in association with his business partner **E A M "Peter" Wright** (1908-1985). Hancock also lobbied the State and Commonwealth Governments over a period of years for the export embargo to be lifted. With Wright he was successful in persuading the London-based Rio Tinto Company, through its managing director **Sir Val Duncan**, to become interested in investing in the Pilbara region.

Sir Maurice Mawby (1904-1977) had a distinguished career in the mining and metalliferous industries. He gained diplomas in metallurgy and geology from Broken Hill Technical College. He was involved in exploration, research and development covering a range of minerals and regions, including Australia, New Zealand and Papua New Guinea. In the 1950s Mawby was appointed a director of the British company Consolidated Zinc Corporation Ltd and an Australian subsidiary

Consolidated Zinc Pty Ltd. In 1962 he was made chairman of the new company Conzinc Rio Tinto Australia Ltd (CRA). He became Hamersley Iron's first chairman, retiring from the board in 1972. Mawby oversaw the intensified search for iron ore in the Pilbara and the development of Hamersley Iron's mines and infrastructure, including the railway. He strongly believed that the initiative, direction and control of Australia's natural resources should be Australian and was backed in this by the Commonwealth Government. However he also saw there was a need for overseas capital to allow large projects to be developed and was an advocate of multinational but Australian-managed companies.

Sir Russel Madigan (1920-1999) graduated in engineering and law and became a leader in the Australian mining industry. He joined Consolidated Zinc Pty Ltd in 1946 and had a notable career with the Consolidated Zinc and Rio Tinto group of companies. Among other appointments he was a director of the British holding company from 1971 to 1985 and deputy chairman of CRA from 1978 to 1987. Madigan worked on the Hamersley iron ore project from its earliest days and was heavily involved in commercial negotiations with Japanese steel mills in the 1960s. During the latter part of the construction period he became managing director of Hamersley Iron and in 1971 he became chairman.

Sir Garrick Agnew (1930-1987) played a key role in developing the Robe River iron ore deposits. He also represented Australia in swimming at the Olympic and Commonwealth Games. Agnew studied engineering at the University of Western Australia and psychology and business in the United States. On his return to Australia he became involved in prospecting for minerals and went into business as an iron ore broker. He was interested in the Robe River deposits, discovered decades earlier, and arranged for **Bill Dohnal**, vice-president of Cleveland Cliffs to visit the area. This led to the formation of Cliffs Western Australia Mining Company Pty Ltd and development of the Robe River project as described earlier.

Sir Ian McLennan (1909-1998) was an eminent person in Australian industry and had a significant influence on the development of the Pilbara railways. In 1932 he graduated from Melbourne University as an electrical engineer and joined BHP as a cadet. In 1955 he became general manager of BHP, and in 1971 was appointed chairman. McLennan strongly supported research and development in the company and instigated closer ties between industry and universities. During the development and early operation of the Mount Newman project he is credited with insisting that BHP's research into Mount Newman's railway problems be shared with the other companies developing railways in the region. This led to close collaboration between MNM and Hamersley in research and development and the dissemination of information to other companies, and had a significant effect on the development of world-leading heavy haul railways.

11 INTERPRETATION PLAN AND PANELS

It is intended that separate panels will be placed at Dampier and Cape Lambert. These will commemorate the original Hamersley and Robe River railways in particular, but also include acknowledgement of the Goldsworthy and Mt Newman railways as parts of the historical Pilbara heavy haul railways. Details of the panels and their exact locations will be discussed and agreed with Rio Tinto as the current owner and operator of the Hamersley and Robe River railways. Rio Tinto has agreed to support the recognition activities.

The unveiling ceremony will be held in 2016, when Rio Tinto will be commemorating 50 years of iron ore production from its Pilbara mines. The actual date is yet to be determined. Consideration will be given to a ceremony at each of the two sites, or to a single ceremony at one location with a replica of the panel for the other location.

12 PROPOSED BUDGET AND FUNDING

A budget will be prepared when details of the interpretation panels and their installation have been agreed. It is likely that Rio Tinto will contribute to the costs.

13 RESPONSIBILITY FOR FUTURE CARE

The original Hamersley and Robe River railways are part of the network operated by Rio Tinto. As such the company will continue to be responsible for their maintenance.

14 ACKNOWLEDGEMENTS

The author wishes to thank the following for their assistance in preparing this nomination:

Staff of Rio Tinto for the provision of information, particularly Jason Brennan and Fiona Lehn

David Flint and Bob Vanselow, railway engineers and Pilbara Railways Historical Society members

Geoffrey Higham of Geoproject Solutions and Australian Railway Historical Society

William Walker, retired Railroad Manager, BHP Railroad

Members of Engineering Heritage WA Committee for review of drafts and suggestions

Prepared for Engineering Heritage Western Australia by Bob Morrison

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APPENDIX

SIGNIFICANT PROJECT DATES

1. BHP BILLITON IRON ORE

1.1 GOLDSWORTHY MINING COMPANY

1965: Goldsworthy Mining Company (JV Consolidated Gold Fields Australia Limited, Cyprus Mines Corporation & Utah Development Company) constructed a 113km (70 mile) 1,435 mm (4ft 8½ in) standard gauge railway line to haul iron ore from Mt Goldsworthy to Finucane Island (near Port Hedland).

Iron ore first railed 1 December 1965.

1972: 43km railway extension from Goldsworthy to Shay Gap/Nimingarra.

1990: BHP Minerals took over Goldsworthy Mining Company major shareholding.

1.2 MT NEWMAN MINING COMPANY

1960: The Australian Government lifts 30 year old Iron Ore export embargo.

1967-68: Mt Newman Mining Company (JV between BHP, American Metal Climax company (AMAX), CSR, Seltrust and Mitsui-C. Itoh (ITOCHU)) constructed a 426km 1,435 mm (4ft 8½ in) standard gauge railway line to haul iron ore from the Mt Whaleback mine (near Newman) to Nelson Point (near Port Hedland). Railroad constructor was Morrison – Knudsen Mannix – Oman (MKMO). 14 Sidings. Consist of 2 locomotives and 138 ore cars with 2 trains a day with train order working.

1969: Iron ore first railed and shipped 8th July 1969.

1975: Mt Newman Mining operated the first Locotrol® (remote control) train in WA – 6 locomotives and 270 ore cars. CTC introduced. Trackcode DC coded track circuits introduced.

1978: Radio repeaters upgraded from wind power to solar power.

1982: Trackside signals introduced.

1986: concrete sleepers introduced for greater axle loads.

1989: 40km rail extension from Mt Newman's Newman main line at Jimblebar Junction to McCamey's Monster mine for Hancock Prospecting Pty Ltd.

1990: BHP Minerals took over Goldsworthy Mining Company major shareholding.

1990: Boodarie rail depot built.

1992: a 30km railway (Marillana) extension to Yandi (from Newman Mainline 280.9km - Yandi Junction) (Y313km) – Yandi 1 mine.

1993: a 25km railway extension from Shay Gap to Yarrie (208km from Finucane Island). Shay Gap mine closed. Goldsworthy Township closed.

1993: solarisation of signalling locations from diesel power.

1994: BHP Minerals took over the McCamey's Monster lease and railway from Hancock Prospecting Pty Ltd. Mine is now known as Wheelarra. (J430.8km)

1994: a 2km Orebody 25 Spur (approximately 20km from Newman) (409km).

1996: Car Dumper 3 and major yard works at Nelson Point. Construction of Jimblebar Junction Yard.

1996: World's heaviest train run – 10 x GE Dash 8 locomotives and 582 ore cars.

1996: a 10km railway extension to Yandi 2 (YT316km).

1999: driver only operation introduced on both mainlines.

2000: 300+ ore car train consists now in service.

2001: BHP merged with Billiton to form BHP Billiton. BHP Billiton Iron Ore group created.

2001: World's longest and heaviest train – Travelled 275km from Yandi Junction to Nelson point with 8 x GE AC6000 and 672 ore cars.

2003: 38km rail extension from Yandi to Mining Area C (MAC) (M348.7km).

2003: siding extensions and new siding installation for 320 car trains.

2004: completion of wooden sleeper removal from mainlines.

2006: 8km Rail extension to Orebody 18 off Jimblebar Spur (J417.4km).

2006-08: extra sidings on Newman mainline, MAC line, Finucane Island Works, Car Dumper 4 (Finucane Island – replacing bottom dump facility) and Goldsworthy Junction works.

2008-09: Newman Yard works, Orebody 25, Jimblebar Loop and Jimblebar Wye.

2009 -10: Proposed Track duplication to Bing to Yandi, and the Yandi 1-Yandi 2 Link.

2. RIO TINTO IRON ORE

2.1 HAMERSLEY IRON PTY LTD

1966: Hamersley Iron (CRA/Kaiser Steel JV) constructed a 292km 1,435 mm (4ft 8½ in) standard gauge railway line to haul iron ore from Mt Tom Price to Parker Point, Dampier. First iron ore train ran in June 1966. Railway officially opened on 1 July 1966. HI shipped its first ore in August 1966.

1972: 95km rail extension to Paraburdoo (386km from Dampier).

1980: East Intercourse Island Dumper and shiploader operational

1992: 43km rail extension from Brockman (294km from Dampier).

1994: 49km rail extension from HI mainline (Rosella 251km mark) to Marandoo (306km from Dampier).

1998: 147km rail extension from Marandoo to Yandicoogina (447km from Dampier).

2000: Rio Tinto acquired North Ltd (53% JV partners in Robe River Iron Associates).

2002: Formation of Pilbara Rail Company (50:50 JV company Robe & HI).

2002: 49km rail extension from Juna Downs to West Angelas (420km from Cape Lambert) and new car dumper at Cape Lambert.

2002: 45km rail duplication Gull to Tunkawanna.

2005: Pilbara Iron formed to manage HI/RRIA Rail, Mine & Port assets.

2005: Dampier Port upgrade (replace Parker Point dumper with Car Dumper 3).

2006: 95km rail duplication Tunkawanna to Rosella.

2007: Dampier Port upgrade (Car Dumper 4).

2007: 74km rail extension from West Angelas spur to Hope Downs (50:50 JV with Hancock Prospecting)

2007: 9.5km Yandi Loop duplication, 5km Quail siding.

2008: 63km, Cape Lambert Yard Upgrade and Green Pool siding.

2008: 7 Mile Yard works and installation of the new Dove siding.

2009: 39km rail extension from Mesa J line to Mesa A.

2.2 ROBE RIVER IRON ASSOCIATES

A joint venture organisation (RTIO has a 53% stake). Includes Cape Lambert to Pannawonica/Mesa J railway, West Angelas Spur and Mesa A extension.

1972: Cleveland-Cliffs Robe River Iron constructed a 168km railway with three sidings between Port Walcott/Cape Lambert (near Point Sampson) and Pannawonica. The first official ore train ran in August 1972.

1975: 4km double track spur at 162.2kp to No. 2 loadout at Robe.

1994: 10km rail extension from Mesa K to Mesa J (Deepdale) (197km from Cape Lambert).

2000: Rio Tinto acquired North Ltd (53% JV partners in Robe River Iron Associates).

2002: Formation of Pilbara Rail Company (50:50 JV Company - Robe & HI).

3. FORTESCUE METALS GROUP LTD

2006: Fortescue Metals Group commenced construction of a 260km 1,435 mm (4ft 8½ in) standard gauge railway line to haul iron ore from Cloud Break Mine to Anderson Point, Point Hedland. First ore train in April 2008.

2010: 50km extension from Cloud Break to Christmas Creek Mine constructed.

2012: 129 km line from Solomon Hub connecting to Fortescue's main line completed.

4. HANCOCK PROSPECTING PTY LTD

2014: Hancock Prospecting commenced construction of a 344 km railway from the Roy Hill mine to Port Hedland. First iron ore export shipment planned for September 2015.

Source: David Flint, 2010 (updated to 2014)